Condensed Matter Physics

THE MORPHOLOGICAL EVOLUTION AND COMPOSITION OF EPITAXIALLY SELF-ASSEMBLED GE/SI(100) QUANTUM DOTS

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Abstract

Recent studies show that creating ideal self-assembled quantum dot arrays may be a successful method of exploiting the quantum realm and revolutionizing electronic and optoelectronic devices. In an effort to generate methods of producing the ideal quantum dot ensemble, the Ge/Si(100) system is being studied as a model for other systems. This study investigates the fundamentals of the Ge/Si(100) system grown by molecular beam epitaxy (MBE). Atomic force microscopy cross-sectional analysis techniques are used to map accurately the facet evolution of the Ge islands grown by MBE at 400°C. A rich array of facets and island morphologies are identified in both the ⟨100⟩ and ⟨110⟩ cross-sections of Ge islands. Furthermore, recent studies have shown that interdiffusion of Si into the Ge epilayer is activated at temperatures above 550°C. Statistical analyses of electron energy loss spectra are used to investigate the composition of the Ge islands as a function of temperature and position. The mean Ge concentration in the islands is found to decrease from 91% to 44% as the growth temperature increases from 400 to 700°C. Furthermore, examination of the Ge/Si interface reveals an increasing width as growth temperature increases. The mean Ge concentration as a function of lateral position in the island is also examined and, within the error of the measurements, no systematic trends are observed.